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Automatic addressing on bus systems

The invention relates to a method for automatic address allocation by control appliances connected to a bus system in a means of transport, where the control appliances interchange data using transmission/reception units via a common data bus line, and the control appliances simultaneously access the data sent using the common data bus line. The invention also relates to a bus system for carrying out the method.

In order to allow communication between control appliances in data bus systems, these control appliances need to have an individual address. This respective individual address allows the control appliances or the subscribers in the data bus system to interchange messages and data with one another. In particular, it is possible to send messages directly to any subscribers in the data bus system. It is normally also possible to ascertain the sender of a message.

In the case of address setting or allocation, it is necessary to ensure that the correct addresses are allocated to the appropriate subscribers. The same addresses must not be allocated a plurality of times to different subscribers, in order to avoid interference. It should be a simple matter to handle the incorporation of a further subscriber into the data bus system and the associated address expansion.

"Daisy Chain" connections are frequently used in data bus systems on means of transport in order to configure the control appliances connected to the data bus system, particularly in order to make address settings.

A "daisy chain" connection is an individual data line

in the form of a point-to-point connection which is in the form of a series or ring connection between a central control unit, the "master", and the other subscribers, the "slaves", in the "daisy chain" connection. The "daisy chain" connection is distinguished in that a signal emitted by the central processing unit on the data line reaches only the first subscriber, is forwarded therefrom to the next subscriber, which in turn forwards the signal to the next subscriber etc. All subscribers can receive identical signals by virtue of the signals not being altered upon forwarding. In addition, in contrast to other bus systems, any subscriber in the chain can change one or more signals before it forwards the signal. The time-delayed forwarding allows a plurality of messages to be forwarded on the "daisy chain" connection, for example the second subscriber can forward an electrical signal to the third subscriber while the master is already sending the next signal to the first subscriber.

In the "daisy chain" connection, the signal return path generally runs directly from the last slave in the chain to the master. Unidirectional communication is permitted on the signal return path. Alternatively, the signal return path may be terminated at the last subscriber by means of a resistor, in which case the data lines should then be in bidirectional form.

Subscribers in a "daisy chain" connection have at least two interfaces for data interchange or for communication via the bus system. One of the two interfaces, particularly the first interface, is in the form of a communication interface for receiving data from a subscriber which is connected upstream in the "daisy chain" connection. A subscriber's second interface is provided as a communication interface for connection to a downstream subscriber in the bus

system. If the "daisy chain" connection is bidirectional, the communication interfaces likewise need to be of bidirectional orientation.

A bus system which is designed using a "daisy chain" connection can only provide communication from master to slave or from slave to master. There is no provision for actual communication between the slaves, that is to say the subscribers in the bus system.

The fact that in a "daisy chain" connection the signals are forwarded from subscriber to subscriber in sections means that the "daisy chain" connection is often called a "non-jointly used connection". In contrast to this, "jointly used connections" are those which can be accessed by the subscribers with equal authority and where all subscribers can receive data simultaneously on account of the electrical or optical connection to the data line, as is implemented in the Control Area Network (CAN) protocol, for example.

Often, the address configuration for the subscribers in an arbitrary bus system is obtained using a (sub)bus system, which is constructed from a "daisy chain" connection, that is to say a non-jointly used connection. The data communication between the subscribers in the data bus system takes place using an additional, jointly used connection which allows individual communication with equal authorization on account of the actual data protocol between the subscribers.

DE 100 38 783 discloses a method and an apparatus for automatic address allocation to a plurality of subscribers in a bus system using "daisy chain" connection. Upon receiving an unmistakable, explicit command from the master in a data packet for address allocation which is received on the first communication

interface, each slave subscriber stores the part which is to be interpreted as an address in an address memory which can be accessed by the respective subscriber, and forwards the data packet with the same command and an altered address value to a neighboring subscriber via the second interface.

DE 37 36 081 A1 discloses a method and an apparatus for address setting by subscribers which are connected to a bus. The subscribers are connected to a central processing unit via a bus. In addition, the subscribers on the bus are connected in series by means of a "daisy chain" connection coming from the central processing unit. The subscribers' address setting is obtained using the "daisy chain" connection. A signal with a particular binary value on the "daisy chain" connection at the input of the first subscriber causes the latter to pick up an available address on the bus from a data packet produced in the central processing unit and to output the particular binary value to the "daisy chain" connection. The subscriber sends the address picked up to the central processing unit as a response. The method then continues at the neighboring subscriber.

It is now the object of the present invention to provide a method and a bus system which optimizes the automatic address allocation in a bus system with a common data line.

The invention achieves this object by means of the features of claim 1. To this end, a period of address allocation is started by means of a message on the jointly used data bus line. After that, the message is taken as a basis, in the period of address allocation, for electrically breaking the common data bus line into individual subsections by virtue of the control appliances which are to be addressed using a respective isolating means for the purpose of electrically

breaking the common data bus line. In addition, the control appliances which are to be addressed place their respective transmission unit at a transmission potential.

Depending on the bus system chosen, the term data bus line covers single-wire or two-wire or multiwire data lines.

The simultaneous reception of data sent on the data bus by means of the control appliances does not mean absolutely simultaneous reception, but rather reception in a time interval which covers the propagation of the electromagnetic wave on the data bus line.

One advantage is that a common data bus line is split into individual subsections for the period of address allocation, which means that a "daisy chain" connection, particularly a "non-jointly used" connection, topology is obtained between the control appliances which are to be addressed as bus subscribers.

Since the common data bus line is used for addressing, no additional data bus line is required between the control appliances. In addition, the control appliances do not need to be equipped with a further bus protocol in order to be able to communicate via the additional data bus line for addressing. Standard control appliances, in which the address setting is intended to be performed using the inventive method, therefore need to be altered only to a minimal extent.

The method has the particular advantage that it can also be used for bus systems containing subscribers with equal authorization, that is to say not a master/slave system as described above. The address allocation merely needs to be initiated by a control

appliance using a signal.

The method also has the advantage that, in contrast to known addressing methods, the master can be positioned at any position in the bus system. The master thus does not need to be positioned at the start or end of the data bus line, as is the case with a "daisy chain" connection. The reason for this is that the start signal for address allocation is obtained at a time at which the common connection is available to all control appliances.

Since the master can be positioned in the bus system as desired, it is a simple matter to extend the address allocation to other control appliances in the existing bus system. By way of example, when control appliances are arranged in series and there is a master at an arbitrary position, the control appliances can be incorporated into the address allocation to the right and/or left of the master.

A further advantage is that the method for address setting can be used in bus systems in which not all control appliances in the bus system are involved in the addressing method, that is to say, by way of example, control appliances configured in standard fashion already exist on the bus system. This is ensured, in particular, by virtue of just control appliances which are to be addressed being involved in the method.

The method can likewise be applied when a further control appliance which is to be addressed is added to or removed from the bus system, since all control appliances to be addressed are involved in the address allocation.

The method is not limited just to bus systems connected

in series. Rather, it may also be used on bus systems with a ring structure, in particular.

It is advantageous for the transmission unit in the control appliance which is to be addressed to turn on and send a signal, because this ensures that there is an electrical parameter for determining whether there is a further control appliance which is to be addressed on the data bus line.

The address to be allocated is independent of the position of the subscriber in the bus system, since the check to determine whether there is a further downstream control appliance to be addressed takes place after a time T_{SG} which is individually stipulated for each control appliance which is to be addressed. This means that the address to be allocated is likewise transmitted to the control appliance independently of the position of the control appliance. There is thus no address allocation required, such as rising address, in line with the order of the position of the control appliances in the bus system.

One advantage is that the method can be applied not just in bus systems containing single-wire data lines but can also be applied in bus systems with two-wire data lines, since the electrical parameter determined is a differential voltage level at the output to the downstream control appliance, as is obtained for determining signal transmission in line with the respective bus system on the data bus line.

The method can thus be used in a bus system based on the LIN (Local Interconnect Network) standard. In line with the LIN protocol, the data bus line provided is a single-wire data line for signal or data transmission. The signal transmission or evaluation takes place in the LIN bus by determining the differential voltage

level between the LIN or the single-wire data line and the ground potential.

The method may likewise be used in a bus system with a two-wire data line, such as a CAN (Controller Area Network) data bus. For signal evaluation on a CAN bus, the voltage difference between the two data lines is measured, which is evaluated in the method as an electrical parameter.

One advantage of the invention is that in the case of a single-wire data line the electrical parameter measured is the current on the data line at the output to the downstream control appliance, since current measurement is easy to implement in the control appliance.

It has advantageously been recognized that if there is a downstream control appliance which is to be addressed then the data line is closed again, using the isolating means, in the control appliance in question which is to be addressed, and the transmission unit in the control appliance in question which is to be addressed is turned off. A control appliance which is to be addressed thus forwards the address setting option to a further control appliance which is to be addressed. By means of this step, it is possible to ascertain an individual control appliance for address setting. The step thus optimizes the method.

It is advantageous for the isolating means to be in the form of a switchable connection, such as a switching transistor or a relay or a repeater, which are available at low cost on the market today.

A further advantage of the method is that it may also be used in optical bus systems by virtue of repeaters being used as isolating means.

The fact that control appliances which are not involved in the addressing do not send any data to the data bus line in the period of address allocation prevents the address allocation from being disrupted. In particular, this method allows the address allocation to be limited to the control appliances which are to be addressed which are involved.

It has advantageously been recognized that in the period of address allocation no control appliance is able to send a signal for connecting the control appliances, that is to say for closing the interrupted data line, to all control appliances, since the data bus line is partially interrupted, of course. For this reason, the period of address allocation is limited to a time T_{MAX}. The control appliances involved in the address allocation restore the common data bus line by reconnecting the interrupted data bus line after the time T_{MAX}, which is known to every control appliance involved.

Advantageously, the start signal already contains the address which is to be allocated, which means that no further signal from a control appliance is needed for the other control appliances which are to be addressed.

It has advantageously been recognized that the period of address allocation is produced as part of an addressing cycle and is started repeatedly by means of automatic flow control until an address setting has been made on all control appliances which are to be addressed.

The automatic flow control has the advantage that this needs to be performed only once using a control appliance. After that, the control appliances automatically start the period of address allocation again after a particular time T_{CYC}. In this context, T_{CYC}

needs to be chosen to be greater than T_{MAX}, since a period of address allocation needs to be concluded first before a further period for renewed address allocation is started.

The automatic flow control may also be performed by virtue of a control appliance repeatedly starting the period for address allocation automatically and accordingly transmitting an address which is to be allocated upon every start signal.

The object is also achieved by a bus system in accordance with claim .... Accordingly, the measuring arrangement has means for controlling the isolating means and the transmission/reception unit in the control appliance in question, the means for control taking the evaluation of the measured signals as a basis for controlling the isolating means and the transmission/reception unit.

One advantage is that by looping the data bus line through the control appliance in conjunction with the isolating means contained in the control appliance the control appliance is able to interrupt a common data bus line and also to reconnect it.

A further advantage is that the changes which are to be made can be implemented with minimal cost involvement on standard control appliances which are already in use on the market.

One advantage which has been recognized is that the development of the measuring arrangement has a comparison means which through simple comparison of input signals produces an output signal which is in turn used to control the transmission/reception unit and the isolating means.

Preferably, the comparison means is in the form of a comparator circuit on account of its switching speed.

There are now various options for advantageously refining and developing the disclosure of the present invention. In this regard, reference will first be made to the subordinate claims and secondly to the explanation of an embodiment which follows. The intention is also to include the advantageous refinements which are obtained from any combination of the subclaims. The drawings show an inventive apparatus for carrying out the inventive method. In these drawings, which are each a schematic illustration,

Figure 1 shows an inventive bus system for carrying out the inventive method, and

Figure 2 shows a control appliance with an inventive measuring arrangement.

The invention relates to a method for automatic address allocation by control appliances 3-6 connected to a bus system 1 in a means of transport, where the control appliances 3-6 interchange data using transmission/reception units 10 via a common data bus line 2, and the control appliances 3-6 simultaneously access the data sent using the common data bus line 2. To this end, a period of address allocation is started by means of a message on the common data bus line 2. After that, the message is taken as a basis, in the period of address allocation, for electrically breaking the common data bus line 2 into individual subsections by virtue of the control appliances 4-6 which are to be addressed using a respective isolating means 9 for the purpose of electrically breaking the common data bus line 2. In addition, the control appliances 4-6 which are to be addressed place their respective transmission unit 10 at a transmission potential.

The figure 1 has a bus system 1 in the LIN standard (Local Interconnect Network - http://www.lin-subbus.org) with a data bus line and control appliances 3-6, the control appliances 3-6 being engine control appliances for air conditioning applications in motor vehicles. The communication between the control appliances 3-6 takes place in line with the LIN protocol with equal authorization on the common data bus line.

The data bus line is designed in line with the LIN standard, that is to say as a single-wire line. The data bus line contains not only the single-wire line, that is to say the actual data or LIN line 2, but also a voltage supply line 8 and a line 7 which is connected to the ground potential. The differential voltage level U_{MEAS} measured on the data line 2 with respect to the ground line 7 is used to transmit and evaluate electrical signals in line with the LIN protocol. The data or messages sent on the data line 2 can be received by the control appliances 3-6 simultaneously.

The data line 2 is of bidirectional design. Since the LIN standard is involved, the data line 2 is not terminated at the last subscriber in the bus system 1, control appliance 6.

The data line 2 for connection between the subscribing control appliances 3-6 is routed such that this connection is obtained by the control appliances 3-6. The data line is thus connected through between the input and output of the control appliance.

The control appliances 3-6 in figure 1 have, as transmission/reception unit 10, an LIN transceiver or LIN bus driver, which ensures that the data are moved to the data line 2 in accordance with protocol. The transmission/reception unit or the LIN transceiver 10

is connected to the data line 2 within the control appliance 3-6. In addition, the control appliances 3-6 have a voltage supply and a microcontroller for performing their function-related tasks.

For the time of the address allocation, the control appliance 3 undertakes the function of the master control appliance and the control appliances 4-6 undertake the function of the slave control appliances.

The master control appliance 3 has a programmed control algorithm which initiates, regulates and monitors the address allocation to the slave control appliance 4-6. The master control appliance 3 ensures the correct address allocation to the slave control appliances 4-6. The master control appliance 3 thus knows the sequence or order and number of the slave control appliances 4-6 which are connected to the bus system 1 and which are to be addressed.

The slave control appliances 4-6 have an isolating means 9 which is in the form of a switching transistor or switch and which can be used to interrupt the data line 2. The switch 9 is positioned between the resistor 11 for the voltage supply line 8, the "pullup resistor", and the LIN transceiver 10.

The control appliances 4-6 each have a measuring arrangement for determining the differential voltage level U_{MEAS}, which has a comparator circuit as comparison means. In addition, the measuring arrangement uses the control unit 17 to control the switch 9 and the transmission/reception unit 10 on the basis of the measurement result.

The slave control appliances 4-6 have a programmed control algorithm which implements the method steps that are to be executed by the slave control appliances

4-6, particularly address setting, measurement of the differential voltage level U_{MEAS}, control of the switch 9 and of the LIN transceiver 10.

The voltage supply line 8 is connected to the data line 2 via a resistor 11, so that the LIN or data line 2 has a defined quiescent voltage, the "recessive level", of U_{BAT} = 12 V in the quiescent state. When the LIN transceiver 10 is turned on, that is to say a signal is sent, the data line 2 is connected through to the ground line 7, so that the differential voltage level U_{MEAS} falls to zero or ground potential, which corresponds to the "dominant level".

It should be noted that an LIN transceiver 10 behaves like a switch: upon turning it on, that is to say when a dominant level is sent, the data line 2 is connected to the ground line in order to obtain the zero signal "dominant level". Upon interrupting it, that is to say when a recessive level is sent or in the quiescent state, the data line 2 is isolated from the ground line 7.

In the normal state, when the control appliances 3-6 communicate with equal authority using the jointly used data line 2, the LIN transceivers 10 of the master and slave control appliances 3-6 which are involved are ready for transmission and reception. The switches 9 for breaking the data line 2 are closed and are thus connected through.

Upon a message from the master control appliance 3 on the common data line 2 to all connected control appliances 4-6, the period for address allocation is started. The message from the master control appliance 3 already contains the address which is to be allocated. The slave control appliances 4-6 to be addressed immediately use the switch 9 to interrupt the

data line 2. From this time onward, it is not possible to send data with equal authority to all control appliances 3-6 in the bus system, since the jointly used data line has been interrupted.

At the same time, the LIN transceiver 10 in the slave control appliances 4-6 which are to be addressed is turned on, so that a connection is made between the ground line 7 and the data line 2.

The control appliances 4-6 now monitor the differential voltage level U_{MEAS} at their respective output, with the differential voltage level U_{MEAS} being determined between the ground line 7 and the data line 2 to the downstream control appliance 4-6.

The differential voltage level U_{MEAS} is measured by the respective slave control appliance 4-6 after a time T_{SG4}, T_{SG5}, T_{SG6} which is individually stipulated for each slave control appliance 4-6 that is to be addressed and which has been disclosed to the respective control appliance 4-6. Each slave control appliance 4-6 takes the measurement result as a basis for deciding whether a further control appliance to be addressed is connected downstream and decides, on the basis of the result, whether it remains a control appliance to be addressed in this period of address allocation or excludes itself from the address allocation in this period of address allocation by connecting the data line 2.

Since the differential voltage level U_{MEAS} is measured in every slave control appliance 4-6 after its time which is individually stipulated for the control appliance, that is to say for the control appliance 4 after the time T_{SG4}, for the control appliance 5 after the time T_{SG5} etc., the recognition of whether there is a downstream control appliance may also have been

concluded for a control appliance 4-6 at any position on the bus system 1 to start with.

It should be pointed out that the individual times T_{SG4}, T_{SG5}, T_{SG6} do not exceed a maximum value T_{MAX}. This maximum time period T_{MAX} is known to all control appliances 3-6 in the bus system 1 and is geared to the point from which the bus system 1 is available for the joint data traffic again. At this time T_{MAX}, the data line isolating switch 9 in the control appliances 4-6 is closed.

If a control appliance 4-6 to be addressed, for example a slave control appliance 5, has a further, downstream slave control appliance 4-6 which is to be addressed in this period of address allocation, for example control appliance 6, available for it, then the voltage measurement produces the ground potential, that is to say a level which is dominant in line with the LIN protocol. The dominant level is obtained because the downstream slave control appliance 6 which is to be addressed has turned on its LIN transceiver 10, and the data line 2 is interrupted such that there is now only a connection between the "pullup resistor" 11 in the upstream control appliance 5 and the turned-on LIN transceiver 11 in the downstream slave control appliance 6.

If a control appliance 4-6 to be addressed, for example control appliance 5, does not have a downstream slave control appliance 4-6, for example control appliance 6, available or a slave control appliance 4-6 which is not or no longer to be addressed in this period of address allocation, then the result of the measurement is the supply voltage which is present on the data line 2 across the resistor 11, that is to say a level which is recessive in line with the LIN protocol. The recessive level is obtained because the downstream slave control

appliances which are not involved in the addressing have connected the data line 2 running in the respective control appliance, and the respective LIN transceiver 10 is no longer turned on.

The measurement of the differential voltage level U_{MEAS} thus corresponds to a voltage measurement using a voltage divider. The voltage divider is formed by two resistors connected in series between the ground line 7 and the voltage supply line 8, where the "first resistor" corresponds to the pullup resistor 11 of a control appliance and the "second resistor" corresponds to the LIN transceiver 10 of the downstream control appliance. The measured voltage level at the voltage measurement point between the resistor 11 and the LIN transceiver 10 is determined by the switching of the LIN transceiver 10, that is to say open or closed.

If the measurement result means that the exemplary control appliance 5 contains a downstream control appliance 6 which is to be addressed, then the LIN transceiver 10 in the control appliance 5 is turned off and the data line 2 is connected by means of the switch 9. Hence, in this address allocation period, no address setting is performed on the control appliance 5. It is necessary to wait for another address allocation period.

On the basis of their respective time T_{SG4}, T_{SG5}, T_{SG6}, the control appliances 4-6 to be addressed thus connect the data line 2 and turn off the LIN transceiver 10 until finally only the control appliance 4 to be addressed which is connected last in the addressing cycle, as seen from the master control appliance 3, now has its LIN transceiver 10 turned on and the data line 2 interrupted.

In the case of this control appliance, for example

control appliance 5, the data line 2 remains interrupted and the LIN transceiver 10 remains turned on until the time T_{MAX} has elapsed. Then, the address transmitted with the start message for the period of address allocation is adopted. The addressing has been concluded for the control appliance 5. The control appliance 5 no longer involves itself in further addressing cycles under the prompting of the master control appliance 3. In the address allocation period, the control appliance 5 will no longer turn on its LIN transceiver 10; the control appliance 5 does not send in the address allocation period. The data line 2 also remains connected in the control appliance 5 for the period of address allocation.

In further cycles, the remaining, as yet unaddressed control appliances, for example control appliance 4, can now be addressed. Thus, in a subsequent cycle, the slave control appliance 4 now recognizes after the time T_{MAX} that there is no downstream slave control appliance 5, 6 to be addressed, since the differential voltage measurement at the output of the slave control appliance 4 does not produce a dominant level. The slave control appliance 4 now adopts the address transmitted by the master control appliance 3.

With this method, the address allocation is started beginning with the slave control appliance 6 to be addressed which is connected last as seen from the master control appliance 3. The last address allocation corresponds to the addressing of the slave control appliance 4 to be addressed which is connected first as seen from the master control appliance 3.

The order of the slave control appliances 4-6 in the connection arrangement on the bus system is crucial for the addressing. In each addressing cycle, it is always the control appliance to be addressed which is

connected last as seen from the master which is addressed, since this control appliance cannot establish a downstream control appliance which is to be addressed.

Figure 2 shows a measuring arrangement by way of example, as is implemented in the control appliances 4-6. The measuring arrangement has a comparator 13 with two inputs 14, 15 and an output 16. The output signal 16 from the comparator 13 is connected via a line to a control unit 17 which takes the comparator output signal as a basis for controlling the switch 9 and the transmission/reception unit 10 in the respective control appliance 4; 5; 6. To this end, an input of the comparator 15 is placed at the potential of the data line 2 at the output of the control appliance 4; 5; 6, which has a recessive or dominant voltage level. An input of the comparator 14 is placed constantly at the quiescent voltage of U_{BATT} = 12 V, that is to say at a recessive level which is tapped off between the ground line 7 and the voltage supply line 8 via resistors 12 in a voltage divider. From the comparison of the two input signals, the comparator ascertains an output signal which indicates whether the input signal 15 has a recessive or dominant voltage level. In line with this output signal, the control unit switches the switch 9 and the transmission/reception unit 10.

The master control appliance 3 knows the order or the arrangement of the slave control appliances 4-6 in relation to the master control appliance 3. This means that the master control appliance 3 is able to perform address allocation in line with the stipulations on the slave control appliances 4-6.

The method is not limited to bus systems based on the LIN protocol. Rather, it may likewise be used on bus systems such as CAN (Controller Area Network), FlexRay,

TTP (Time Triggered Protocol), D2B (Domestic Digital Bus), MOST (Media Oriented Systems Transport), since the latter's data communication is based on single-wire or two-wire data lines. In the case of bus systems with two-wire data lines, such as CAN, the switch 9 needs to be present for both data lines.

The transmission/reception unit 10, in this case in the form of a LIN transceiver, is geared to the chosen bus protocol and bus system.

The switch 9 for switchably interrupting the data line 2 is in the form of a switching transistor. Alternatively, the switch may also be in the form of a relay. For bus systems whose data line 2 is in the form of an optical data line, it is advantageous for the switch to be in the form of a repeater which does not forward the data during addressing, that is to say during interruption.

The exemplary embodiment is in the form of a "daisy chain" connection with series-connected control appliances 3-6, the master control appliance 3 being positioned at one end of the series circuit, and the slave control appliances 4-6 being connected downstream of the master control appliance 3 in just one direction.

Alternatively, the method may be used in bus systems in which, for a series circuit, the slave control appliances 4-6 are situated to the left and right of the master control appliance 3. In this case, the master control appliance 3 simply behaves in the address allocation period like a control appliance which is not to be addressed. The master control appliance does not interrupt the data line and also does not turn on its transmission unit in the address allocation period. This means that bus systems with

control appliances arranged in a series circuit require no isolating means, that is to say no additional modification, for the master control appliance.

In bus systems which are designed in a ring topology, the master control appliance, that is to say the control appliance which initiates the addressing, has to interrupt the data bus line and hence the ring without switching in its transmission unit. The master control appliance would thus need to have an isolating means for interrupting the data line, like the slave control appliances.

The measuring arrangement for measuring the electrical parameters may also be in the form of a current measuring device in a single-wire data line system like the LIN bus system. In this context, the measuring arrangement measures the current which flows from the output of the upstream slave control appliance to the input of the downstream slave control appliance.

The comparison means is in the form of a comparator circuit in the exemplary embodiment. Alternatively, the comparison may also be made by means of software, that is to say using a program. In this case, the comparison means is the processor with the software program running on it, which performs the comparison.

In addition, the control unit 17 and the comparison means 13 may be combined as one hardware chip, for example ASIC. This is suitable particularly when the comparison is performed by means of software.

In the exemplary embodiment, the address to be allocated is given at the same time as the start signal whenever the address allocation period starts. The address to be allocated can also be calculated by an algorithm implemented in the slave control appliance,

with the address to be allocated being formed automatically on an up-to-date basis using the algorithm. An example of such an algorithm is address counter imcrementation. The address allocation using an algorithm implemented in the slave control appliance is appropriate particularly in connection with automatic flow control of the addressing cycles. In this context, the master initiates the addressing only once. After that, the unaddressed slaves repeat this cycle after a common waiting time T_{CYC}, which needs to be greater than T_{MAX}, the address allocation until the last slave control appliance has been addressed.